U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB-299 184

A Cost Index Format for BATEA Achievement by the Iron and Steel Industry

IIT Research Inst, Chicago, IL

Prepared for

Industrial Environmental Research Lab, Research Triangle Park, NC

Jan 79

United States
Environmental Protection
Agency

Industrial Environmental Research
Laboratory
Research Triangle Park NC 27711

EPA-600/2-79-025
January 1979

Research and Development

PB 299184

EPA

A Cost Index Format for BATEA Achievement by the Iron and Steel Industry

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

RESEARCH REPORTING SERIES

Research reports of the Office of Research and Development, U.S. Environmental Protection Agency, have been grouped into nine series. These nine broad categories were established to facilitate further development and application of environmental technology. Elimination of traditional grouping was consciously planned to foster technology transfer and a maximum interface in related fields. The nine series are:

1. Environmental Health Effects Research
2. Environmental Protection Technology
3. Ecological Research
4. Environmental Monitoring
5. Socioeconomic Environmental Studies
6. Scientific and Technical Assessment Reports (STAR)
7. Interagency Energy-Environment Research and Development
8. "Special" Reports
9. Miscellaneous Reports

This report has been assigned to the ENVIRONMENTAL PROTECTION TECHNOLOGY series. This series describes research performed to develop and demonstrate instrumentation, equipment, and methodology to repair or prevent environmental degradation from point and non-point sources of pollution. This work provides the new or improved technology required for the control and treatment of pollution sources to meet environmental quality standards.

EPA REVIEW NOTICE

This report has been reviewed by the U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policy of the Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/2-79-025		PB299184

4. TITLE AND SUBTITLE	5. REPORT DATE
A Cost Index Format for BATEA Achievement by the Iron and Steel Industry	January 1979
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
L. L. Huff and J. D. Stockham	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
IIT Research Institute 10 West 35th Street Chicago, Illinois 60616	1BB610
	11. CONTRACT/GRANT NO.
	68-02-2617, Task 2-4
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711	Task Final; 8/77 - 1/78
	14. SPONSORING AGENCY CODE
	EPA/600/13

15. SUPPLEMENTARY NOTES IERL-RTP project officer is John S. Ruppersberger, Mail Drop 62, 919/541-2733.

16. ABSTRACT The report describes a study to develop a format for Best Available Technology Economically Achievable (BATEA) cost analysis, including pertinent cost data. The format is to aid Regional U.S. EPA personnel in evaluating economic appeal cases for BATEA. Through discussion with U.S. EPA Regional personnel and a review of cost engineering literature, two sample formats were developed: one for capital investment; the other for operating costs. The cost analysis formats were designed specifically for application to the iron and steel industry; although, with modification, they could be used for other industries as well. General information regarding various cost components is provided as a basis for analyzing cost estimates presented by specific iron and steel plants.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B
Iron and Steel Industry	Stationary Sources	11F
Cost Analysis	BATEA	14A
Cost Engineering		
Capitalized Costs		05A
Operating Costs		

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Unlimited	Unclassified	46
	20. SECURITY CLASS *(This page)*	22. PRICE
	Unclassified	A03-A01

EPA Form 2220-1 (9-73)

EPA-600/2-79-025

January 1979

A Cost Index Format for BATEA Achievement by the Iron and Steel Industry

by

L.L. Huff and J.D. Stockham

IIT Research Institute
10 West 35th Street
Chicago, Illinois 60616

Contract No. 68-02-2617
Task No. 2-4
Program Element No. 1BB610

EPA Project Officer: John S. Ruppersberger

Industrial Environmental Research Laboratory
Office of Energy, Minerals, and Industry
Research Triangle Park, NC 27711

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, DC 20460

j. a

ABSTRACT

The formulation of a format for BATEA cost analysis and inclusion of pertinent cost data were the objectives of this study. Such a format is to serve as an aid to regional U.S. Environmental Protection Agency personnel who evaluate economic appeal cases for BATEA.

Through discussion with U.S. Environmental Protection Agency regional personnel and review of cost engineering literature, two sample formats, one for capital investment and one for operating costs, were developed. These cost analysis formats were designed specifically for application to the iron and steel industry, although, with modification, such a format could be utilized for other industries as well.

General information regarding various cost components is provided as a basis for analyzing cost estimates presented by specific iron and steel plants.

This report was submitted in fulfillment of Contract No. 68-02-2617, Task No. 4, by IIT Research Institute under the sponsorship of the U.S. Environmental Protection Agency.

CONTENTS

Abstract ii
Figures and Tables iv

1. Introduction 1
2. Summary and Conclusions 2
3. Presentation of Cost Guideline Format 3
   Guidelines for Cost Evaluation 3
   Description of Capital Cost Items 4
   Land 4
   Storage Facilities 4
   Piping 4
   Instrumentation 4
   Site Preparation 4
   Equipment 6
   Engineering Costs 6
   Construction Costs 6
   Contingency 9
   Description of Operating Costs Items 9
   Fixed Costs 9
   Description of Variable Costs 14
   Cost Information 16

References 33
Exhibits 34
Appendix

A. Comments from US-EPA Regional Personnel Regarding Draft Cost Format 38

FIGURES AND TABLES

Figure		Page
1	Piping Cost Curves	5
2	Pump Cost Curves	7
3	Aeration System Cost Curves	8
4	BATEA Operating Costs for By-Product Coke Process	17
5	BATEA Operating Costs for Iron-Making Blast Furnace	18
6	BATEA Operating Costs for Basic Oxygen Furnace	19
7	BATEA Operating Costs for Electric Arc Furnace	20
8	BATEA Operating Costs for Open Hearth Furnace	21
9	BATEA Operating Costs for Beehive Coke Plant	22
10	BATEA Capital Investment for Open Hearth Furnace	23
11	BATEA Capital Investment for Electric Arc (Wet) Furnace	24
12	BATEA Capital Investment for By-Product Coke	25
13	BATEA Capital Investment for Sintering Strands	26
14	BATEA Capital Investment for Blast Furnace	27
15	BATEA Capital Investment for Basic Oxygen Furnace	28
16	BATEA Capital Investment for Electric Arc Furnace (Semi-Wet)	29
17	BATEA Capital Investment for Continuous Casting	30
18	BATEA Capital Investment for Vacuum Degassing	31

Table		Page
1	Chemical Costs	14
2	Treatment Technology	32

SECTION 1

INTRODUCTION

To formulate a cost index and accompanying explanatory guideline for use by U.S. Environmental Protection Agency (EPA) regional personnel in evaluation of Best Available Technology Economically Available (BATEA) appeal cases was considered the primary goal of this effort. Consultation with the regional offices, review of the iron and steel cost literature, and analysis of available cost formats were the most important activities in the development of a cost format.

The actual format developed, comments by regional personnel, and a description of the limitations and utilization of such a cost format are presented herein. Such discussions of the format should provide a perspective of the feasibility and applicability of the cost format as it pertains to the iron and steel industry.

SECTION 2

SUMMARY AND CONCLUSIONS

A cost index format to be utilized by the iron and steel industry in preparation of Best Available Technology Economically Available (BATEA) appeal cases is valuable to U.S. Environmental Protection Agency regional personnel if it provides a consistency for presentation, backup cost data sources, and explanations of the cost elements.

Flexibility in cost estimating is important but also a range of costs and cost elements which are considered appropriate should be defined.

Continued expansion and inclusion of cost data in the guideline for treatment processes other than those designated for BATEA would be beneficial.

SECTION 3

PRESENTATION OF COST GUIDELINE FORMAT

A uniform and consistent approach to cost estimation is important in evaluating economic appeal cases for BATEA requirements. The steel-making industry is perhaps one of the most complex and most significant in terms of pollution requirements. Therefore, the age and layout of individual steel-making facilities may lead to BATEA appeal cases. This guideline has been developed to aid in the evaluation of the cost elements presented by industry.

There are two major cost categories, capital cost and operating expense. Each is needed to present a complete characterization of the economic hardship to be incurred. Because each plant has unique treatment requirements for achieving BATEA levels, it is difficult to provide cost information which can be meaningfully applied. Rather, by stipulating a complete and fully detailed cost estimate from the appealing facility and comparing this to established cost values, areas for discussion or investigation may appear. The attached forms, Exhibits 1 and 2, should be completed by the steel company according to accompanying instructions.

For both cost categories detailed, guidelines are presented in the following section as well as a description of each unit cost item. This should provide the EPA reviewer with an understanding of the costs being incurred and insight into the manipulation of the data presented by the company. These guidelines are based upon the needs and concerns expressed by regional US EPA personnel and some of their comments in Appendix A.

GUIDELINES FOR COST EVALUATION

The capital and operating costs submitted by the appealing steel company should be itemized in Exhibits 1 and 2. To analyze these submitted costs, it is helpful to have background information regarding expected ranges for certain cost components. In the following sections data are presented to aid in the evaluation of costs presented in the BATEA appeal process.

The first section describes the characteristics of the capital cost items, provides general information, cost curves, and references useful for evaluating capital costs. The second section presents similar data for operating cost elements. This information provides a general background for understanding the costs incurred for BATEA.

DESCRIPTION OF CAPITAL COST ITEMS

Land

When additional pollution equipment is required, land may be needed to layout the treatment process, especially for settling and biological activity. In space limited facilities, a premium upon space may be stipulated in terms of the price perceived.

Storage Facilities

The only type of storage facilities which may be included would be for chemicals used in pollution treatment, such as lime, activated carbon, soda, and so forth.

Piping

There will be piping changes required for additional equipment, redirecting waste streams, and handling recirculation of treated water. Depending upon the plant configuration, a wide range of costs may be anticipated. The following descriptions of piping costs depict the range of values available:

a) Piping costs for process units vary from 0.9% to 8.9% of the equipment cost, and this does not include interconnecting piping costs.[1]

b) Process piping costs may run as high as 100% of the purchased-equipment cost.[2]

c) Typical cost curves for piping cost are presented in Figure 1. These costs represent 1968 values and can be upgraded to 1977 by use of the Marshall and Swift Cost Index, which results in an adjustment factor of 1.47.[3]

Instrumentation

Additional controls for level, flow, pH, temperature, pressure and nutrient addition may be added as the treatment of waste streams is upgraded.

Site Preparation

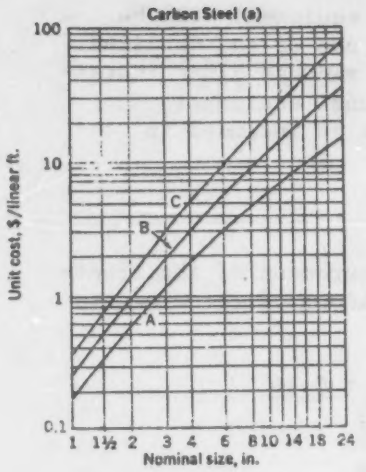
These costs include all grading and preparation work for use of land for pollution control facilities. Both equipment and labor costs are incorporated into this value.

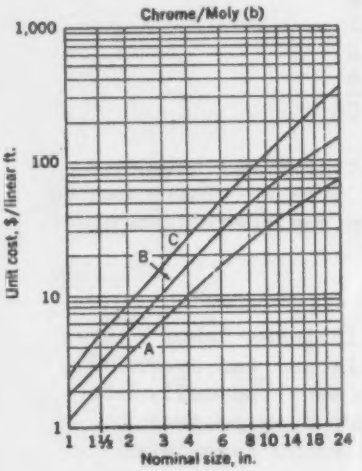
---

[1]Popper, H. Modern Cost Engineering Techniques. McGraw Hill Book Co. New York, 1970.

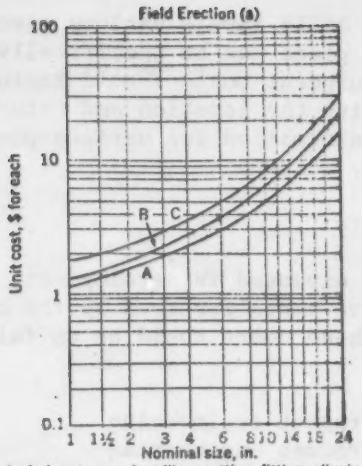
[2]Hasellparth, J.E. and J.M. Berk. Chem. Eng., 67 (10):158 (1960).

[3]Popper, H. Modern Cost Engineering Techniques. McGraw Hill Book Co. New York, 1970. pp. 163.

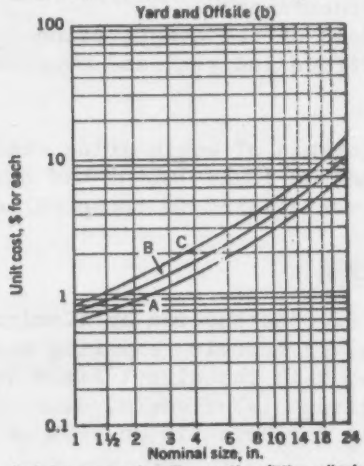




A Standard weight, sch. 40
B Extra strong, sch. 80
C Double extra strong, sch. 160



Includes storage, handling, cutting, fitting, aligning on pipe racks. No line welds, stress relief or X-ray.



Includes storage, handling, cutting, fitting, aligning on pipe racks. No line welds, stress relief or X-ray.

NTIS is authorized to reproduce and sell this report. Permission for further reproduction must be obtained from the copyright proprietor.

Figure 1. Piping Cost Curves.

Source: Popper, Herbert, Modern Cost Engineering, 1972, p. 163
© (Used with permission of McGraw-Hill Book Co.)

Equipment

To achieve BATEA levels various pieces of pollution equipment will be required. Each piece can be specifically categorized by use of the detailed list. These equipment costs should include installation expense since installation varies with the location and nature of the additional equipment. Specific cost information for various pieces of equipment is included in Figures 2 and 3.

Engineering Costs

The effort expended in development, design, and procurement of the treatment facility are costs incurred by the company. A breakdown of the elements considered in these costs could be as follows:[4]

	Percent of Cost
Project engineering	14.3
Process engineering	4.5
Design and drafting	26.8
Procurement	2.7
Home office construction	0.8
Office indirect and overhead	50.9
TOTAL	100.00

The relationship of engineering costs to the project cost has been typically considered to be 10% of the equipment costs of Item 6. There can be a considerable variability in these values depending upon the specific project.

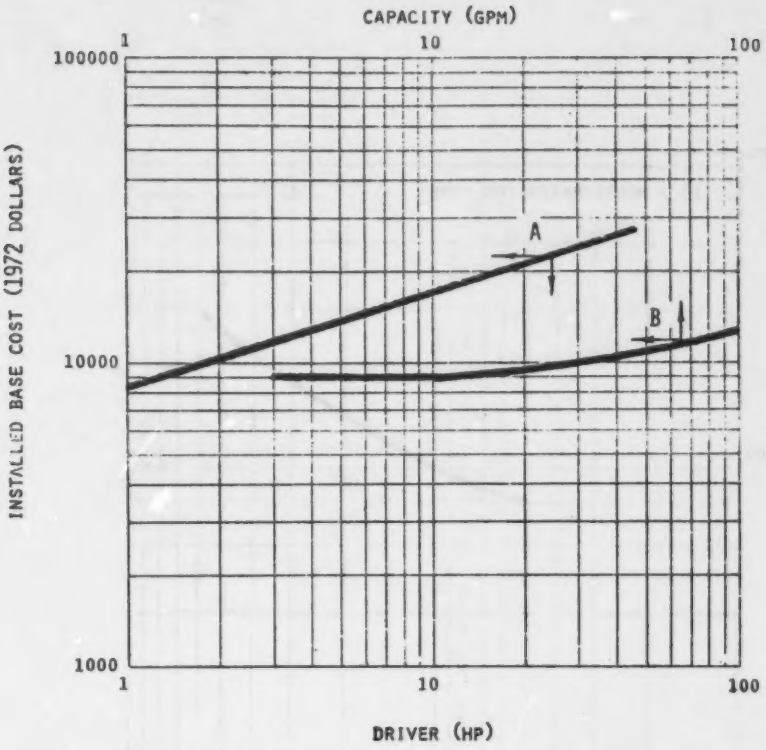
Construction Costs

The costs of construction as itemized in Exhibit 1 includes labor costs for dismantling, or removing existing structures, field labor, and overhead costs associated with the direct field labor. Overhead costs typically are 60% to 80% of direct labor costs, although such costs vary from project to project, and the following is an example of the cost breakdown associated with this item:[5]

Overhead Elements	Percent
Fringe benefits	14.8
Labor burden	22.4
Field supervision	17.8
Temporary facilities	8.9
Construction equipment	14.8
Small tools	3.6
Miscellaneous	17.7
TOTAL CONSTRUCTION OVERHEAD	100.0

[4]Ibid, pp. 85-86.

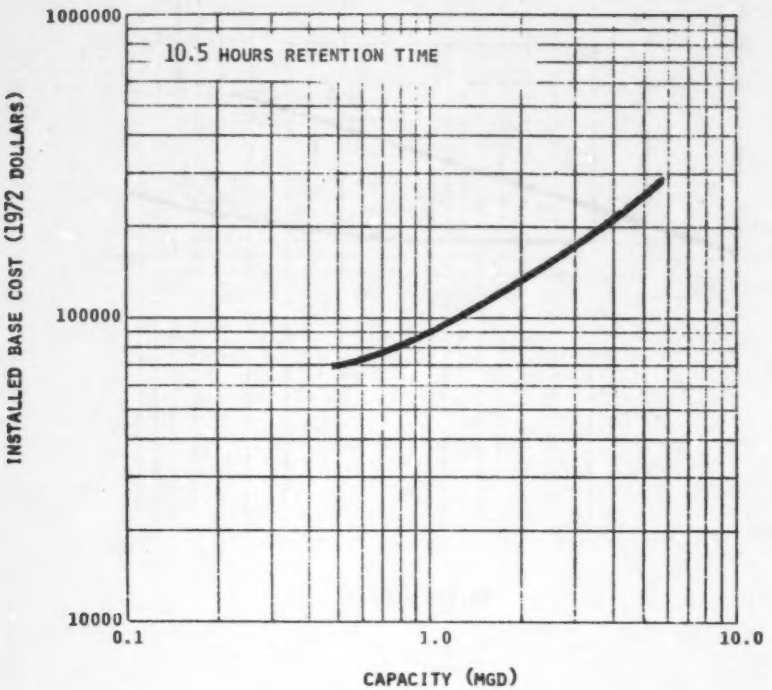
[5]Ibid, pp. 84-85.



DESIGN ADJUSTMENT			REGIONAL ADJUSTMENT	
Type	Curve	F_D	Region	F_R
Simplex	A	1.000	1	1.000
Duplex	A	1.298	2	1.064
Triplex	A	1.960	3	0.978
Diaphragm	B	1.000	4	1.034
Slurry	B	1.104	5	1.076
Rotary	B	0.466	6	1.027
Gear	B	0.590	7	1.066
			8	1.029
			9	1.067
			10	1.033

Figure 2. Pump Cost Curves

Source: U.S. Environmental Protection Agency, Capital and Operating Costs of Pollution Control Equipment Modules, No. 2.



REGIONAL ADJUSTMENT

Region	F_R
1	1.000
2	1.045
3	0.947
4	1.043
5	1.133
6	1.041
7	1.066
8	1.065
9	1.067
10	1.029

Figure 3. Aeration System Cost Curves

Source: U.S. Environmental Protection Agency, Capital and Operating Costs of Pollution Control Equipment Modules, No. 2.

The specific description of the items listed in the overhead is as follows:

Fringe Benefits: Employer's contribution to union funds for health and welfare, vacations, holidays, sick leave, retirement. Add monies for travel and subsistence when required.

Labor Burden: Employer's mandatory contributions for Federal Social Security (FICA), Federal Unemployment Insurance (FUE), State Unemployment Insurance (SUI) Workmen's Compensation.

Field Supervision: Salaries, fringe benefits and burden items for supervisory and field personnel. Add travel and subsistence when necessary.

Temporary Facilities: Buildings, roadways, parking yards, work areas, scaffolding, rigging, utilities, fencing, and miscellaneous.

Construction Equipment: Equipment rental and handling, plus freight to and from the jobsite.

Small Tools: Expendable construction tools, usually valued at $200 or under.

Miscellaneous Field Costs: Job cleanup, watchmen, minor equipment repairs, medical services, welder tests, consumable supplies, warehousing, vendor services, job insurance such as public liability (PL), public damage (PD), automobile, and all-risk.

Contingency

The contingency fund covers unexpected expenses and is usually a standard percentage of the project cost. Such a fund should be minimized for these pollution projects.

DESCRIPTION OF OPERATING COST ITEMS

These costs are defined as the incremental costs of achieving BATEA levels. Operating costs include not only variable costs but also fixed costs, such as overhead, depreciation, and cost of capital. Guidelines for both of these items will be described herein.

Fixed Costs

Depreciation--

Depreciation is "an accounting procedure for allocating outlays for capital assets such as buildings and equipment over a reasonable and acceptable life."[6] Companies charge an annual cost for depreciation in their operating expenses as a standard practice; however, the method of computing the depreciation cost may vary significantly. Three variables, salvage value,

---

[6]Uhl, V.W., Draft, "A Standard Procedure of Economic Evaluation for Pollution Control Operations," IERL/RTP, U.S. EPA, November, 1977.

equipment life, and depreciation method, determine the size of the annual costs of depreciation. Salvage value is the market price or usefulness remaining in a piece of equipment at the time of replacement. Pollution equipment is typically considered to have a "0" salvage value after full depreciation. An equipment life or depreciation period of 10 to 18 years has usually been selected for pollution control equipment; however, for integrated steelmaking facilities considering closure, a shorter life span may be required. The effect of a change in the useful life can best be illustrated for three different methods of depreciation.

METHOD 1

STRAIGHT LINE DEPRECIATION

Base Data

Value of equipment = $10,000
Salvage value = 0
Equipment Life = 5 years (A) or
10 years (B)

Calculation Method

$$\text{Annual Depreciation Cost} = \frac{\text{equipment price - salvage value}}{\text{life of equipment}}$$

METHOD 2

SUM-OF-THE-DIGITS DEPRECIATION

Calculation Method

$$\text{Depreciation cost in year "t"} = \left[\frac{n-(t-1)}{n(n+1)/2}\right] \times (C-S)$$

where:

n = equipment life in number of years
C = initial cost
S = salvage value

METHOD 3

DOUBLE-DECLINING DEPRECIATION

Calculation Method

Depreciation cost in year "t" = $2(\frac{1}{n})(C - S - \sum_{r=1}^{t-1} D_r)$ or $C(1 - \frac{2}{n})^n$

where:

n = equipment life in years
C = initial cost
S = salvage value
ΣD_r = sum of the depreciation in year "1" through t-1

Case A: Five Year Equipment Life

Year	Annual Depreciation Cost for Sum-of-Digits Calculation	Annual Depreciation Cost for Straight-Line Calculation	Annual Depreciation Cost for Double-Declining Depreciation
1	$3330	$2000	$4000
2	2670	2000	2400
3	2000	2000	1440
4	1330	2000	860
5	670	2000	520

Case B: Ten Year Equipment Life

Year	Annual Depreciation Cost for Sum-of-Digits Calculation	Annual Depreciation Cost for Straight-Line Calculation	Annual Depreciation Cost for Double-Declining Depreciation
1	$1820	$1000	$2000
2	1640	1000	1600
3	1450	1000	1280
4	1270	1000	1024
5	1090	1000	819
6	910	1000	655
7	730	1000	524
8	550	1000	419
9	360	1000	336
10	180	1000	269

There are five specific depreciation techniques which may be used by companies in calculating the depreciation expense. In addition to the straight line, double-declining, and sum-of-the digits depreciation methods, the rapid amortization and additional first year depreciation offer other variations. The following description of these two variations was taken from a U.S. Technology Transfer document:[7]

> The Tax Reform Act of 1969 provides for the rapid amortization of certified pollution control facilities over a 60-month period, irrespective of the guideline useful life of the equipment. This amortization is available under certain conditions outlined in Article 169 of the Internal Revenue Code (IRC). The rapid write-off was provided to encourage capital investment in pollution control. Significantly, a process change, even if it results in lower pollution, does not qualify as a pollution control device and cannot be rapidly amortized.
>
> As originally legislated, the eligibility period for rapid amortization would have expired January 1, 1975. However, additional legislation extended that period for 1 year. Further extensions are currently being considered.
>
> The rapid amortization applies to the first 15 years of equipment life. The portion of the asset value with a useful life of over 15 years can be depreciated by any method under Article 167 and depreciation can be taken immediately on that portion. The rapid amortization can begin the month after installation and continue for a full 60 months, or it can begin in the next fiscal year. For the intervening months until the next fiscal year begins, a traditional depreciation method can be used.
>
> An additional first year depreciation (Section 179, IRC) amount of 20 percent of a maximum asset value of $10,000 or a maximum deduction of $2,000 can be taken in the first year of an asset purchase. The "bonus" first year depreciation can be taken if a taxpayer elects to take the rapid amortization or any other method of depreciation.

The difference in depreciation techniques is important in estimating cash flows and annual costs to the company. With the double-declining and sum-of-the digits depreciation techniques, the first year depreciation costs for Case A are 100% and 66% greater, respectively. In Case B, the longer equipment life increases the difference in depreciation method with the double-declining and sum-of-the digits depreciation methods resulting in 100% and 82% greater costs than straight line depreciation in the second year. Thus, in reviewing the annual operating costs, the depreciation method, salvage life, and average equipment life should be specified.

---

[7]U.S. Environmental Protection Agency. Choosing Optimum Financial Strategies. Technology Transfer. June, 1976. p. 6.

Cost of Capital and Method of Financing--

The method of financing pollution control equipment affects the cost at which the monies can be utilized (cost of capital). The choice of using retained earnings, long-term bonds, or a stock issue is associated with different interest rates, and thus there can be some variation in the cost of capital used for pollution control. The steel industry presently finances capital expenditures through a combination of internal and external tools; however, in the last ten years only 5 percent of the total financing requirement has been external to the company. This means retained earnings and depreciation have been primary sources of capital.[8] The capital requirements of pollution control and modernization will cause a greater use of external financing through bond and stock issues according to the US EPA draft economic impact report. The average industry capital costs associated with yields on common stock and interest rate on long-term bonds are 3.5 percent* and 9 percent respectively. If the profitability of the steel industry does not improve and especially for individual plants even higher rates may be required to attract investors. Thus, in evaluating the cost of capital for an individual plant, there will be a range of values, depending upon the method of financing and profitability of the firm. Acceptable rates of return for manufacturing facilities are approximately 15% and 8% for support facilities.

Computation of the annual capital expense associated with the pollution control capital expenditures depends upon the cost of capital (interest rate) and number of years for the investment recovery. The capital formula for calculating capital and interest recovery in equal, annual payments is the following:

$$C_R = \frac{i(1+C)^n}{(1+i)^n - 1}$$

where i = interest rate on project (8% to 15% would be acceptable range)
n = number of years
C = capital investment

The average interest rate "i" is a combination of the external financing methods utilized to obtain the required capital.

---

*This is the historical real rate of return the steel industry has achieved: however, the average manufacturing rate of return is 7%. To externally finance pollution expenses a return of 7% is necessary.

[8]Temple, Barker, Sloane, Inc. Draft, Economic Analysis of Proposed and Interim Final Effluent Guidelines for Integrated Iron and Steel Industry. March, 1976.

Description of Variable Costs

Chemicals--

Several types of chemicals may be used to treat wastewaters satisfactorily. Lime, chlorine, and soda are the ones most commonly used. The appealing company will provide the quantity and type of chemical required. In Chemical Marketing Reports the prices of bulk chemicals are printed weekly. In Table 1 the present prices and coding system is provided. For specific cost information it is best to contact manufacturers for a direct quote. A listing of manufacturers is contained in the Chemical Week's 1978 Buyer's Guide.

TABLE 1. CHEMICAL COSTS[9]

Chemical	Units	Price	Qualification
Chlorine	ton	$135.00	f.o.b., tanks
Lime (pebble)	ton	25.00	bulk of 50,000 lbs., f.o.b.
Soda ash	ton	57.00	58%, paper bags, c.l.
Soda caustic	ton	140.00	liquid, 50%, f.o.b., 76% Na_2O basis

c.l. (car lot)
f.o.b. (free on board)

Labor--

Additional labor may be required to operate pollution control facilities and handle analytical requirements. Both maintenance and operating labor have been aggregated, although different labor rates are likely.

The labor rates utilized by A.D. Little were based on 1972 costs of $7.10 per hour or 1975 costs of $10.20 per hour. In terms of 1977 dollars, this value is now $12.00 per hour in the iron and steel industry.

Maintenance--

Maintenance costs are composed of labor and material expenses. Maintenance requirements for pollution control equipment can be estimated based upon previous experience, as a percentage of plant investment, or as a percentage of labor requirements. Below are examples of the range of values used in estimating maintenance costs.

[9]Chemical Marketing Reporter, November 14, 1977.

Maintenance Cost Estimation Techniques

a) Total maintenance cost may be 3.5% of plant investment.[10]

b) Maintenance material cost may be 4% of plant investment.[11]

c) Total maintenance cost may be between 4% and 8% of plant investment depending upon plant conditions.[12]

d) Total maintenance cost may be 0.5% of plant investment.[13]

Supervision--

A portion of the costs of supervision may be included in the incremental operating costs of pollution control equipment. This may be estimated by typical costs through experience or calculation rules. The following examples depict the range of costs which would be appropriate.

1) Supervision costs equal 10% of all labor costs.[14]

2) For quick estimates and in the absence of other information, supervision can be assumed to average between 10 and 25% of the operating labor. Higher figures are for complex processes or a multiplicity of small units.[15]

Utilities--

To operate pollution control facilities will require electricity, steam, water, air, and fuel. For each region these costs will vary depending upon the source of power and fuel type. In the monthly publication by the U.S. Department of Commerce, Survey of Current Business, wholesale price indices for electricity, coal, oil, and natural gas are printed for each month. These indices can be used to update regional cost information on fuel costs.

To determine regional utility prices the Federal Power Commission publishes the prices of natural gas, oil and coal as purchased by the electric generating industry. (These prices must be closely watched since contract prices represent low, long term rates and would serve as a minimum value while spot market prices represent current fuel prices.) The FPC publication No. 22 contains this fuel information. Industrial power costs can be obtained from the FPC publication Typical Electric Bill Rates for any region in the United States.

---

[10]U.S. Environmental Protection Agency. Draft Development for Effluent Guideline Limitations for the Iron and Steel Industry.

[11]Arthur D. Little. Steel and the Environment: A Cost Impact Analysis. May, 1975.

[12]Popper, H. Modern Cost Engineering Techniques. McGraw Hill Book Company, New York. 1970, p. 243.

[13]Tihansky, D. "Polution Control in Steelmaking: Fact or Fiction?" January, 1971.

[14]Arthur D. Little. Ibid.

[15]Popper, H. Ibid., p. 249.

In addition to the charge for gas, oil, and power consumed by pollution control facilities, there can be an allocation charge for the portion of capital costs associated with production of utility services. For example, if there were an on-site generator which serviced the manufacturing facility, a portion of the capital cost could be allocated to the pollution control project.

Overhead--

Overhead may be defined in various ways depending upon plant/company cost accounting techniques. There are direct and indirect overhead expenses. Direct overhead may include plant supervision (this is considered a separate item in the cost format) as well as the fringe benefits associated with employees. These include insurance costs, sick days, vacation, and pension expenses. These fringe benefits could also be incorporated into the labor costs.[16] Indirect overhead includes auxiliary services, such as secretaries (plant office expenses), guards, cafeteria, accounting, purchasing, and plant engineering (plant engineering is a separate item). Indirect overhead varies from 40% to 60% of the sum of direct labor, repair labor, and direct overhead labor costs.[17]

Waste Disposal--

Solid wastes may be generated during wastewater treatment. These materials can be either hauled away to landfill, or stored on-site. The costs for landfill disposal depend upon the waste content, percent solids, and pH of the material.

COST INFORMATION

In addition to the general discussion of each cost element, specific cost information is included as a reference guide. In the Arthur D. Little, Incorporated report, Steel and the Environment: A Cost Impact Analysis, capital and operating cost data were formulated based upon the steel industry input. Cost curves derived from these data represent the most definitive and complete information available regarding BAT expenses. Where US-EPA cost estimates are available, these have also been included to provide a basis for comparison.

Table 2 summarizes the treatment technology upon which cost estimates were formulated. In Figure 4 through Figure 9 the BAT operating costs for various plant sizes are derived, and in Figure 10 through Figure 18 the BAT capital cost curves are illustrated. These 15 curves are based upon 1972 dollar values, and to update these costs to 1977 dollars, the construction and operating cost indices can be used, which are taken from Chemical Engineering magazine.

---

[16] Popper, H. Modern Cost Engineering Techniques. McGraw Hill Book Company, New York. 1970, p. 243.

[17] Ibid., p. 242-244.

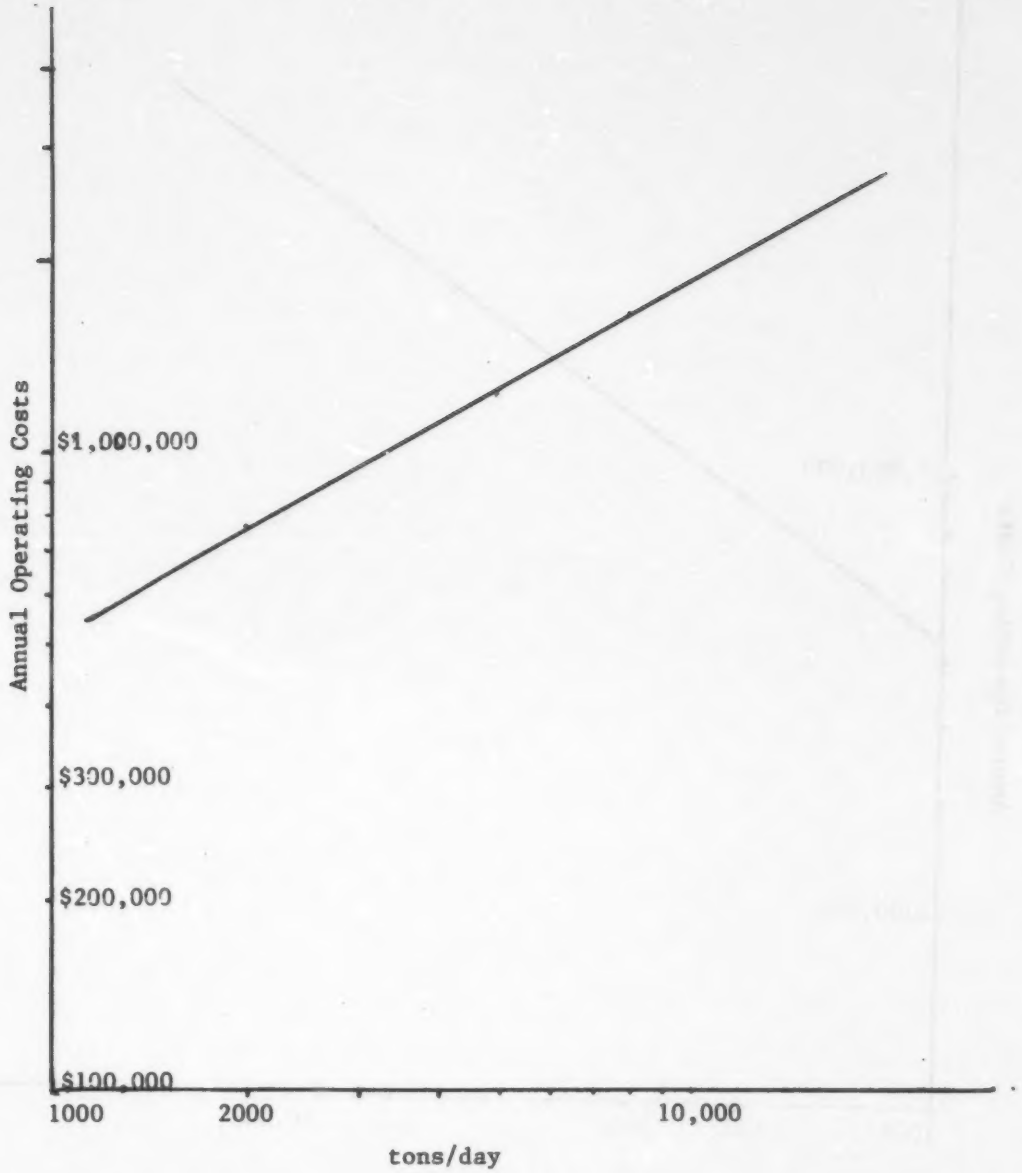


Figure 4. BATEA Operating Costs for By-Product Coke Process

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis May, 1975. (Table B-9.)

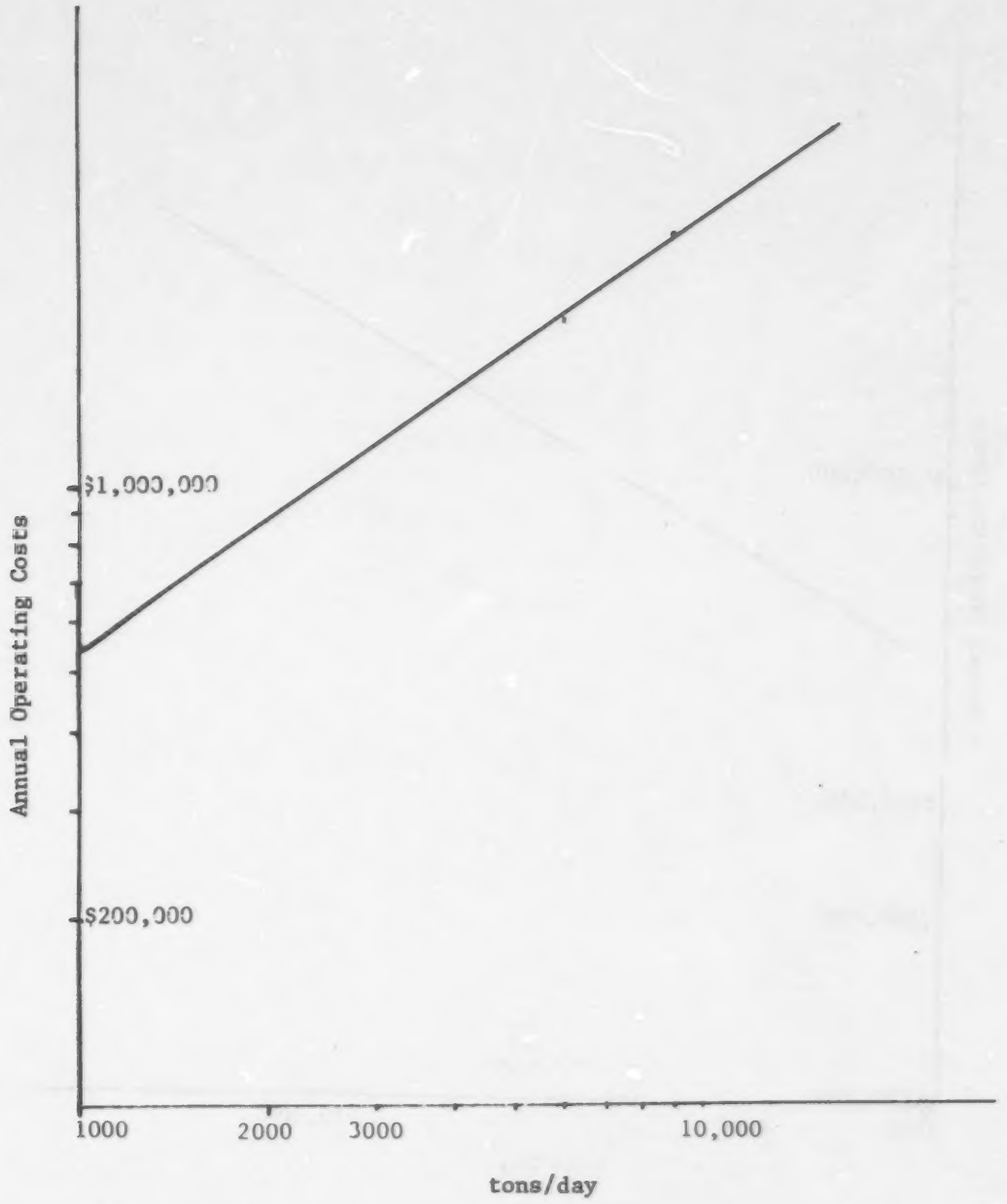


Figure 5. BATEA Operating Costs for Iron-Making Blast Furnace

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Table B-9.)

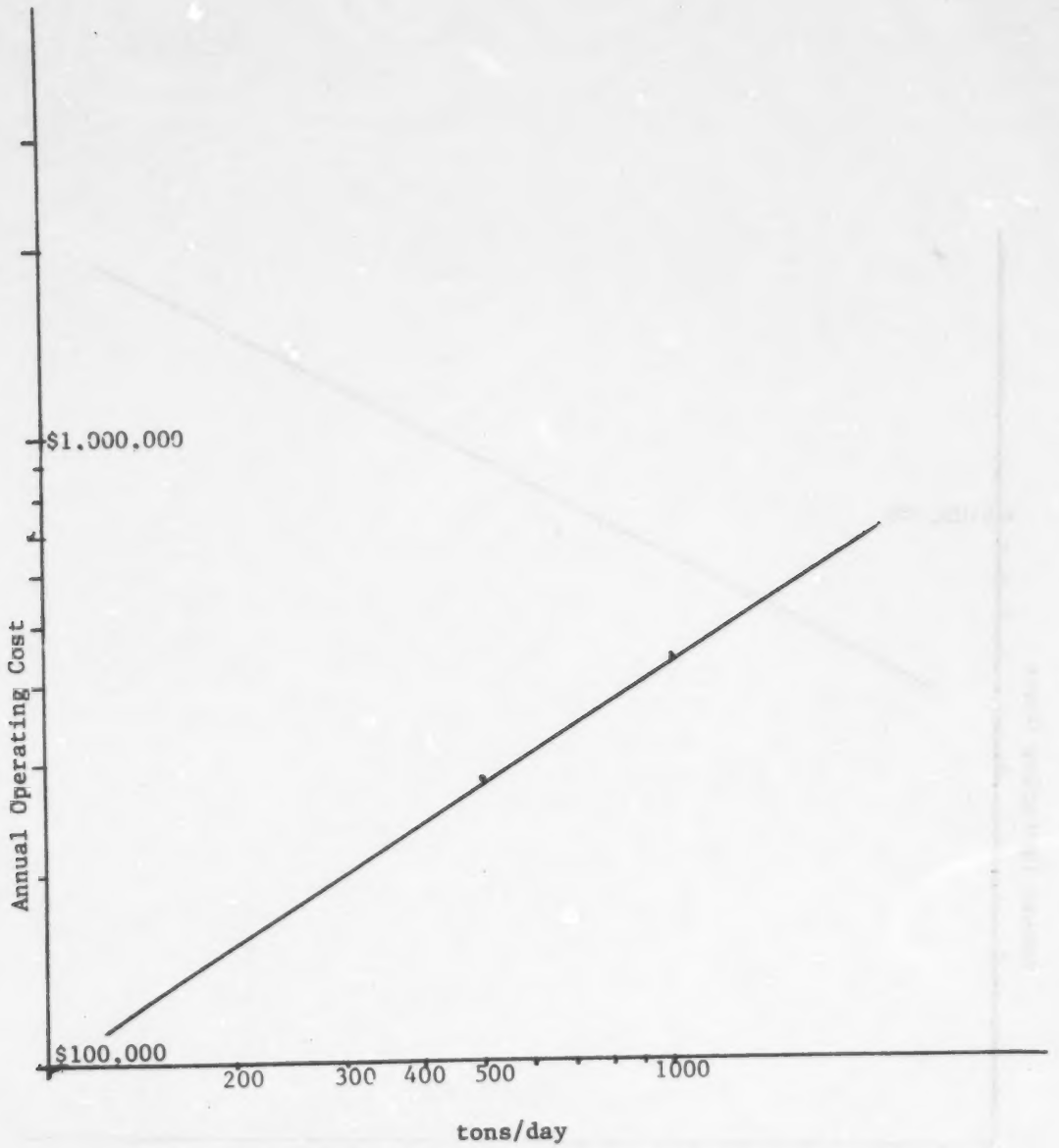


Figure 6. BATEA Operating Costs for Basic Oxygen Furnace

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975.(Table B-9.)

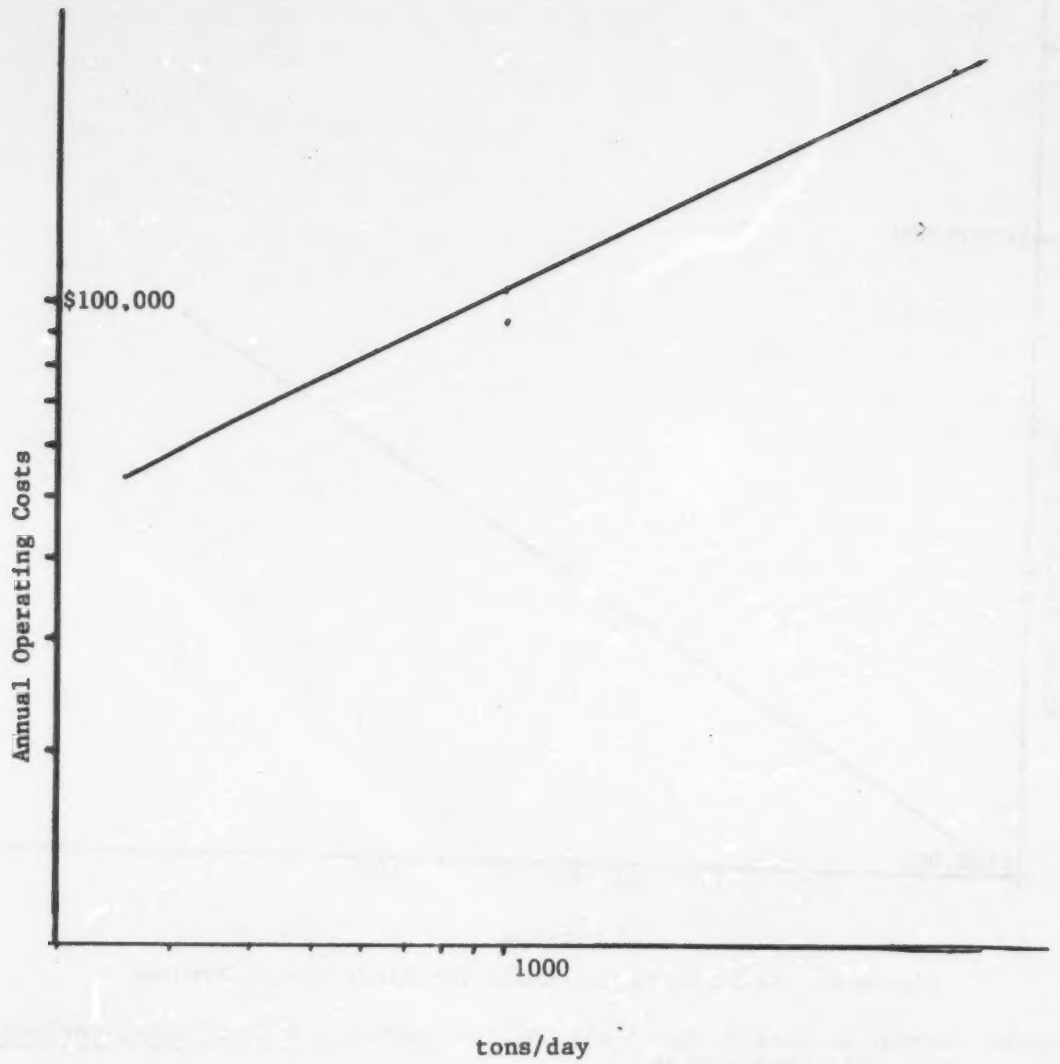


Figure 7. BATEA Operating Costs for Electric Arc Furnace

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Table B-9.)

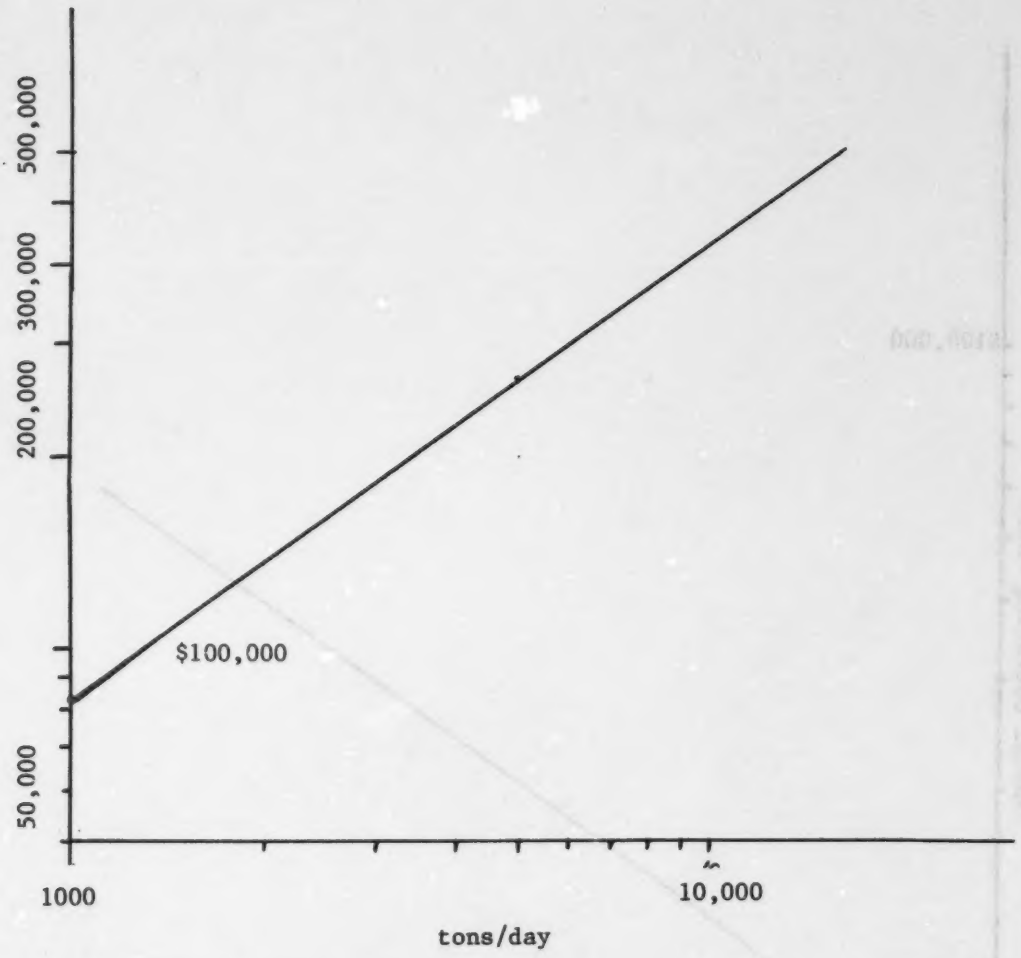


Figure 8. BATEA Operating Costs for Open Hearth Furnace

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Table B-9.)

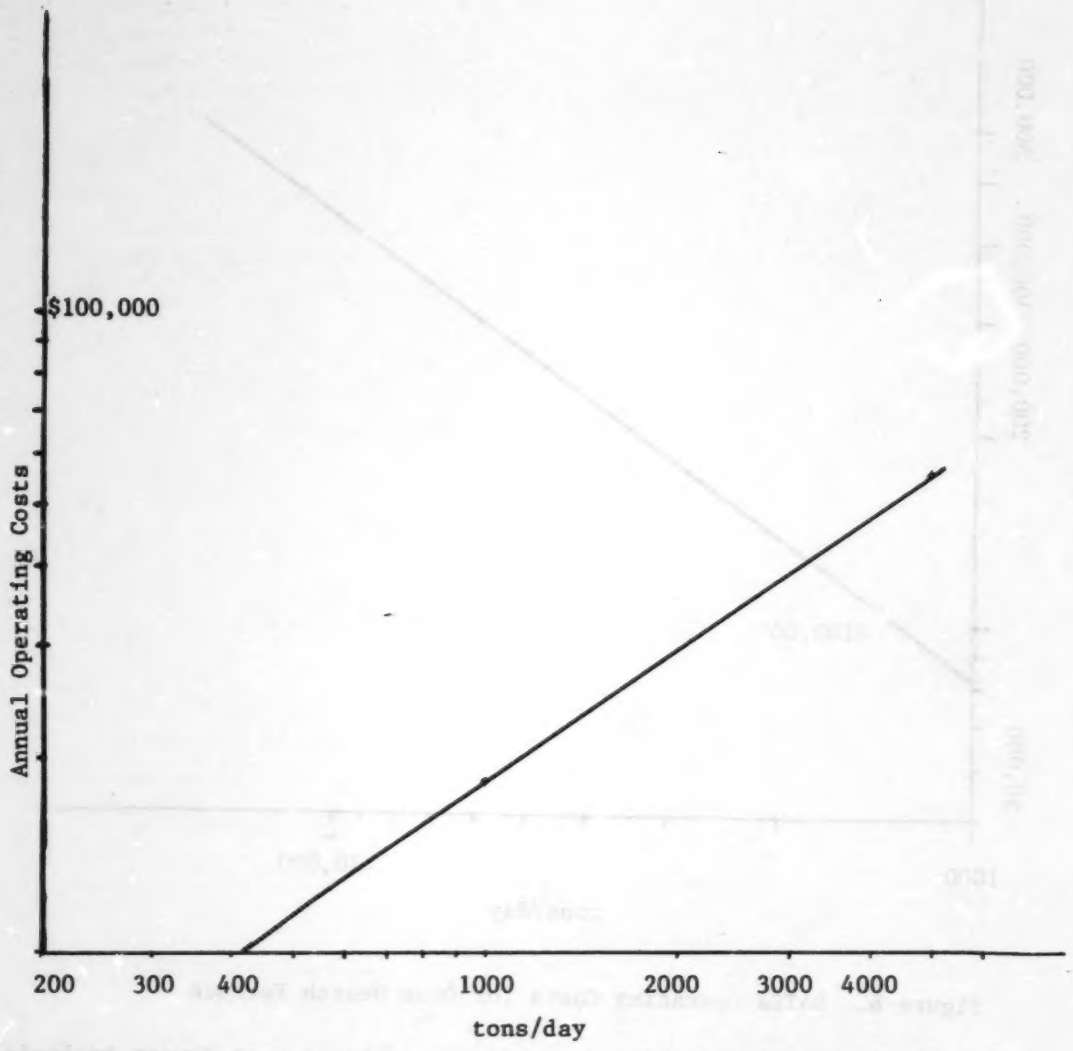
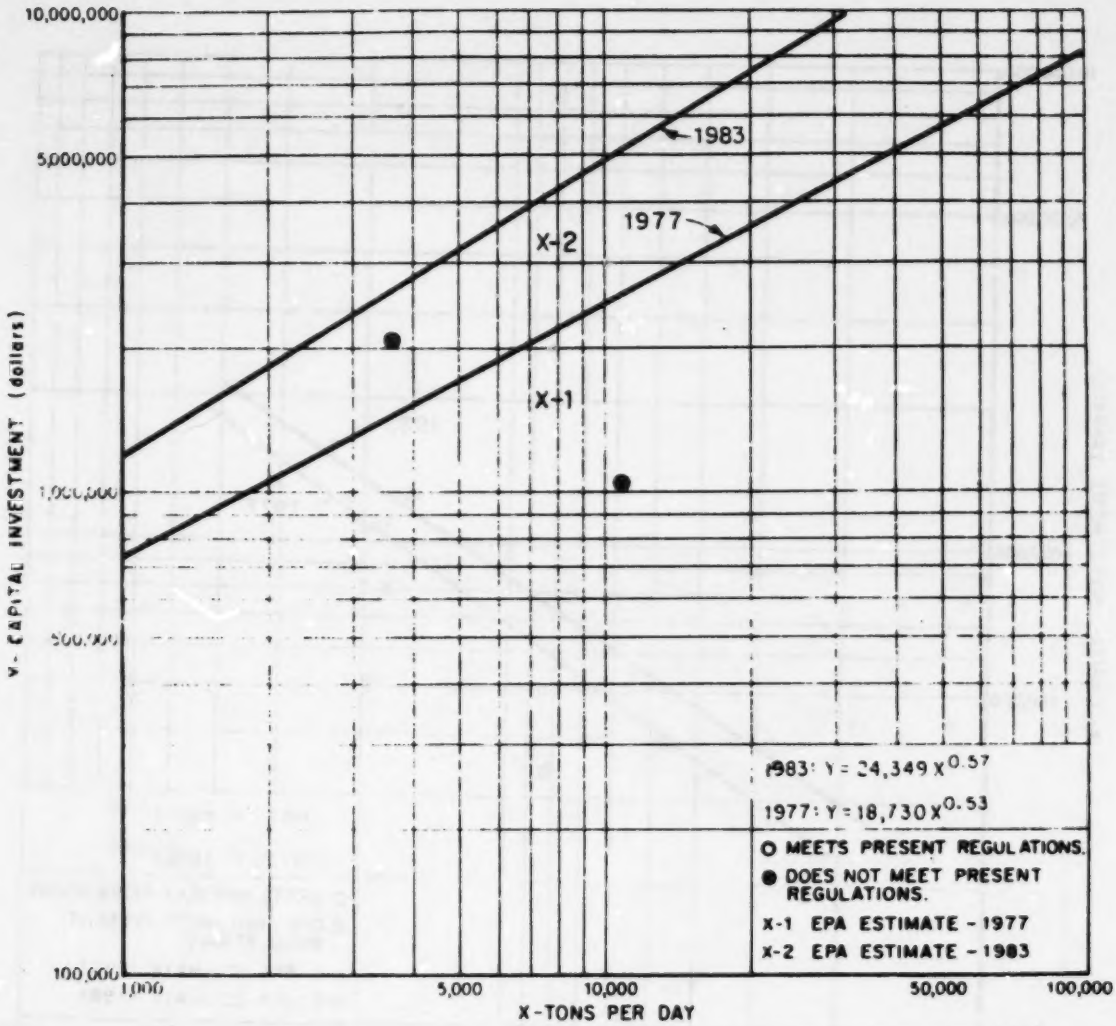


Figure 9. BATEA Operating Costs for Beehive Coke Plant C

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Table B-9.)



NTIS is authorized to reproduce and sell this report. Permission for further reproduction must be obtained from the copyright proprietor.

Figure 10. BATEA Capital Investment for Open-Hearth Furnace (1972 Basis).

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis May, 1975. © (Used with permission of American Iron and Steel Institut

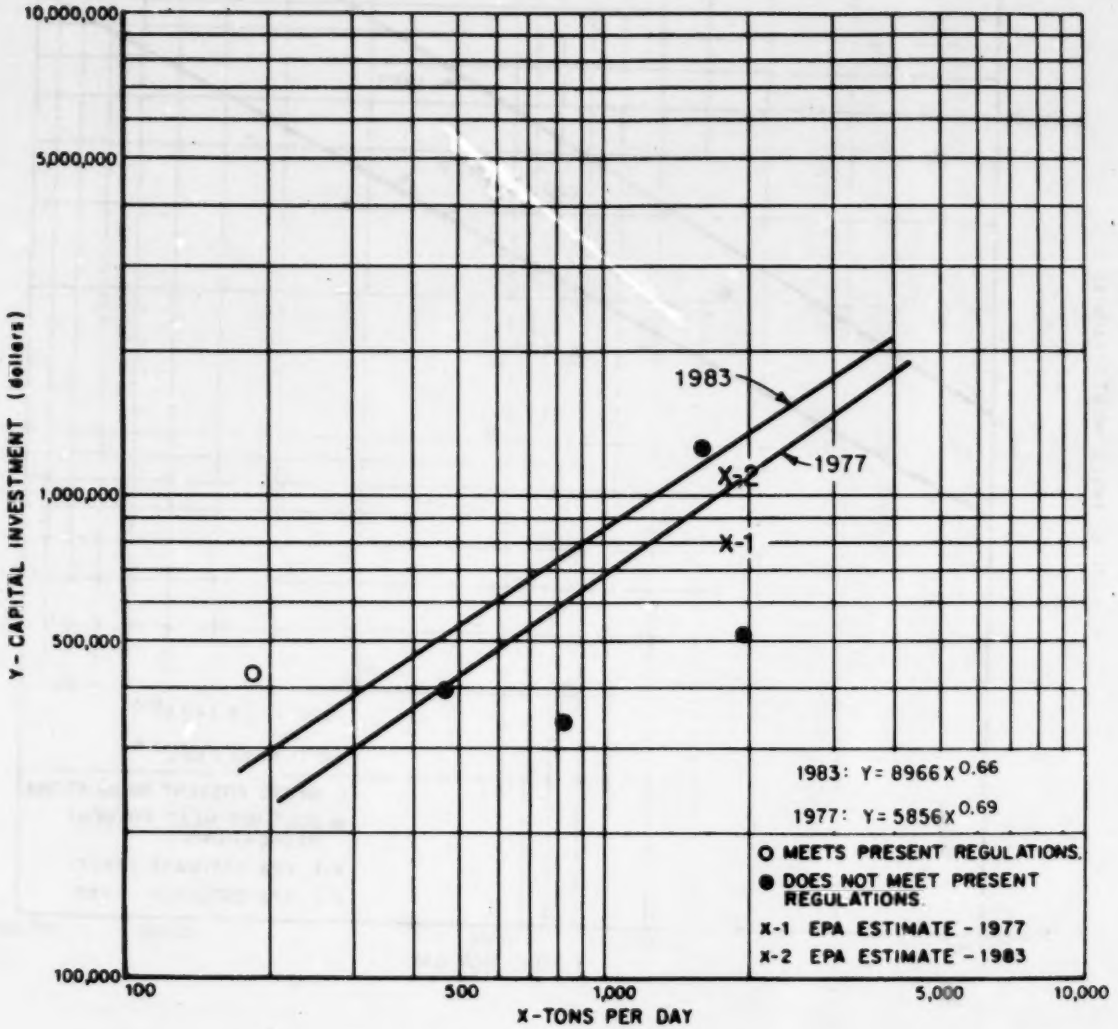


Figure 11. BATEA Capital Investment for Electric Arc Furnace - Wet Process

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis May, 1975. (Used with permission of American Iron and Steel Institute.)

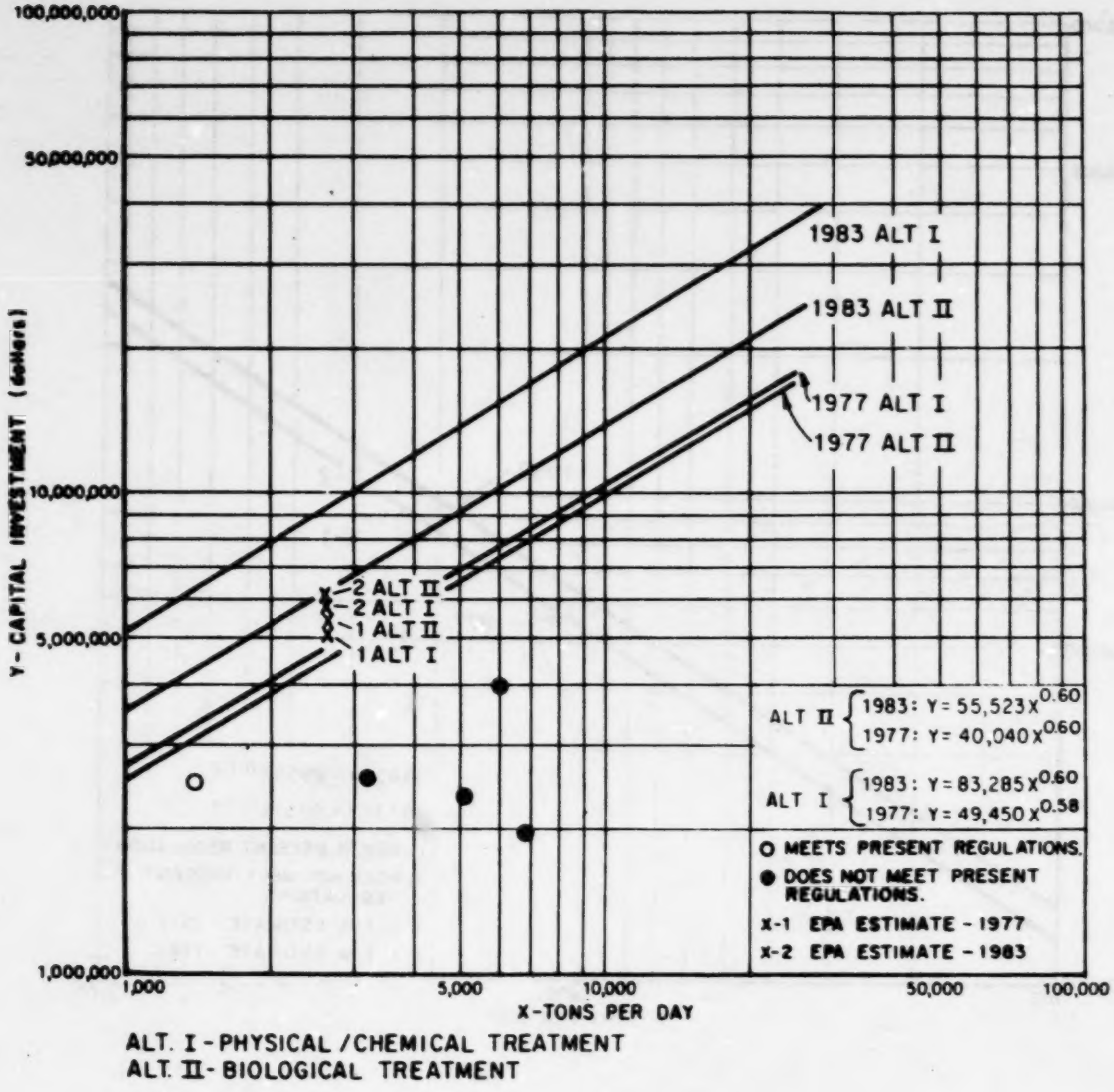


Figure 12. BATEA Capital Investment for By-Product Coke (1972 Basis).

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis May, 1975. (Used with permission of American Iron and Steel Institute.)

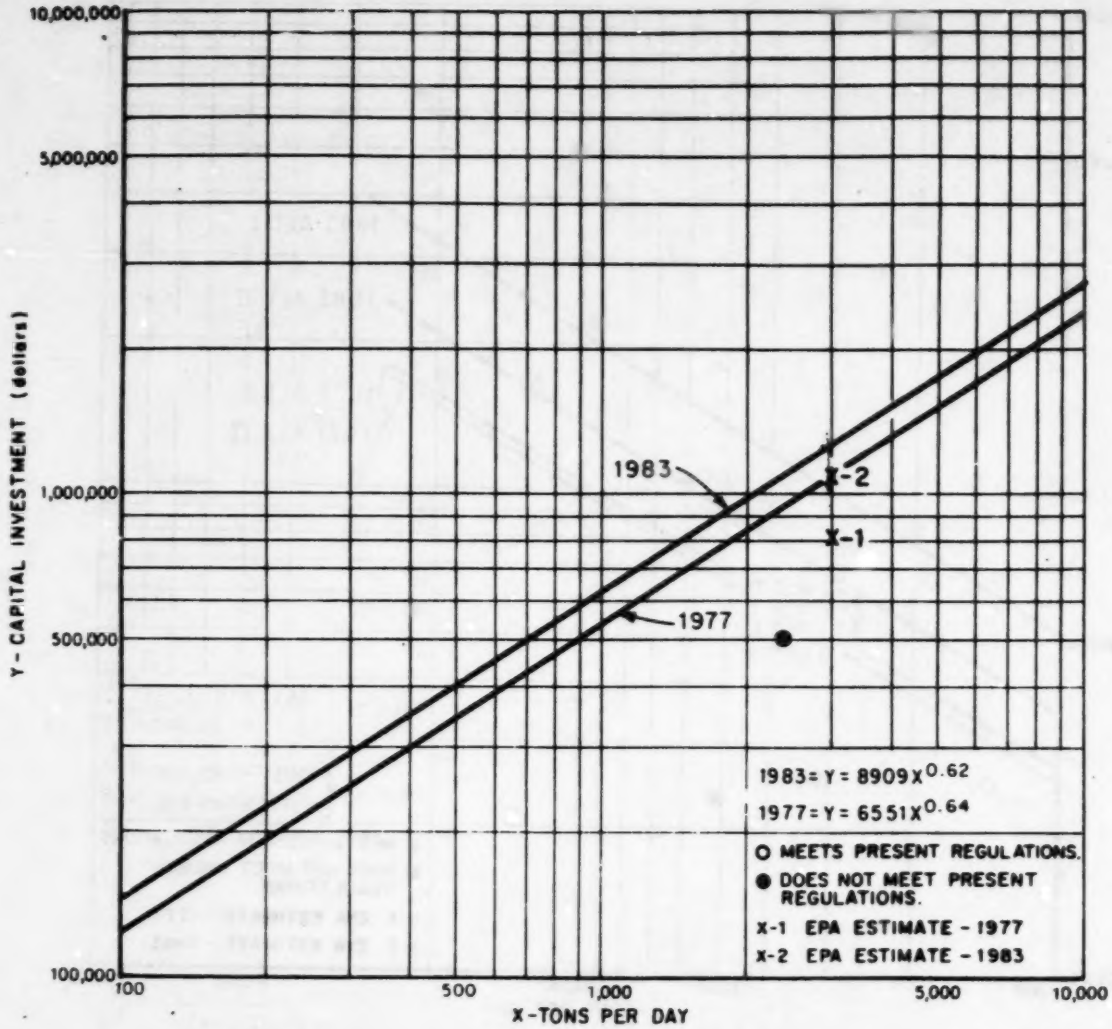


Figure 13. BATEA Capital Investment for Sintering Strands (1972 Basis).

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Used with permission of American Iron and Steel Institute.)

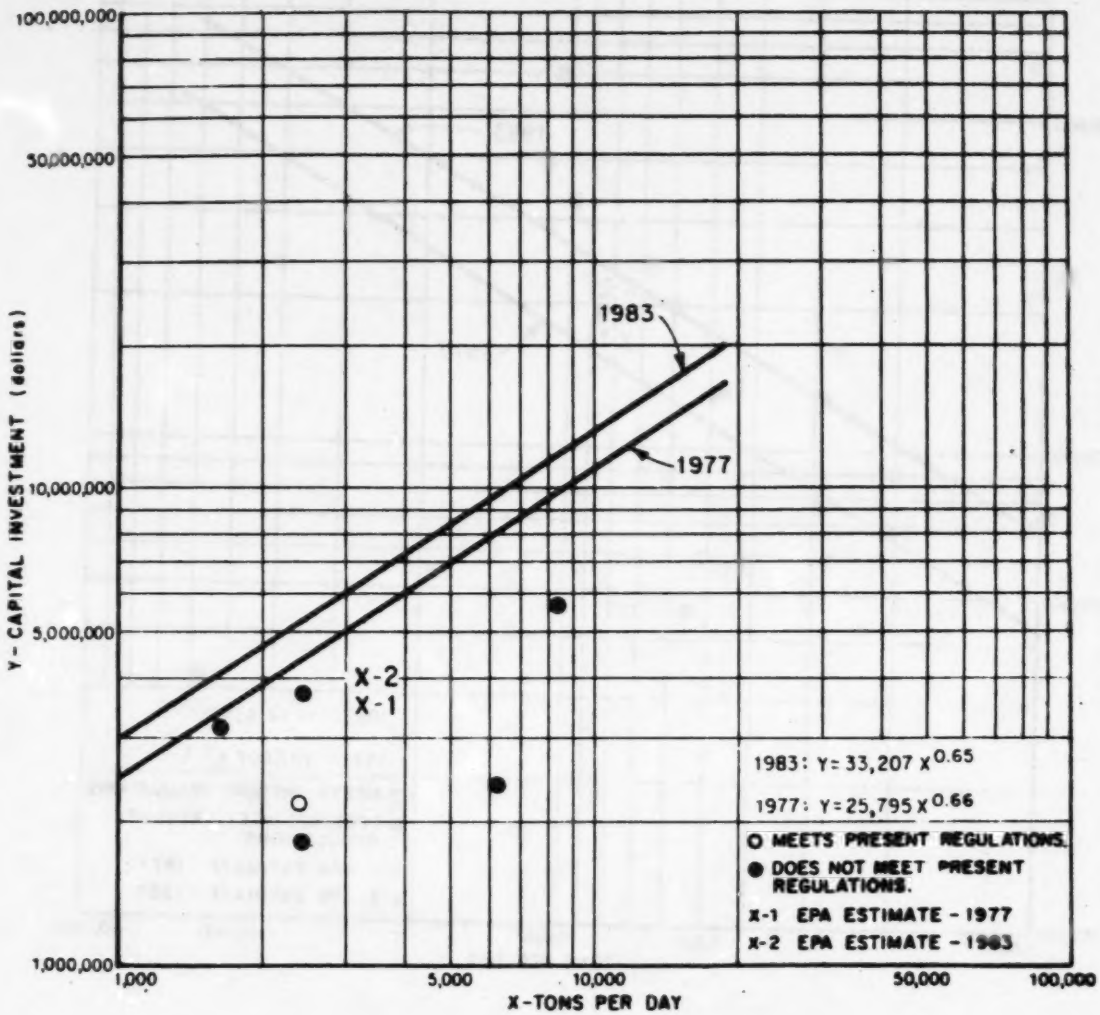


Figure 14. BATEA Capital Investment for Blast Furnace, Iron (1972 Basis).

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Used with permission of American Iron and Steel Institute.)

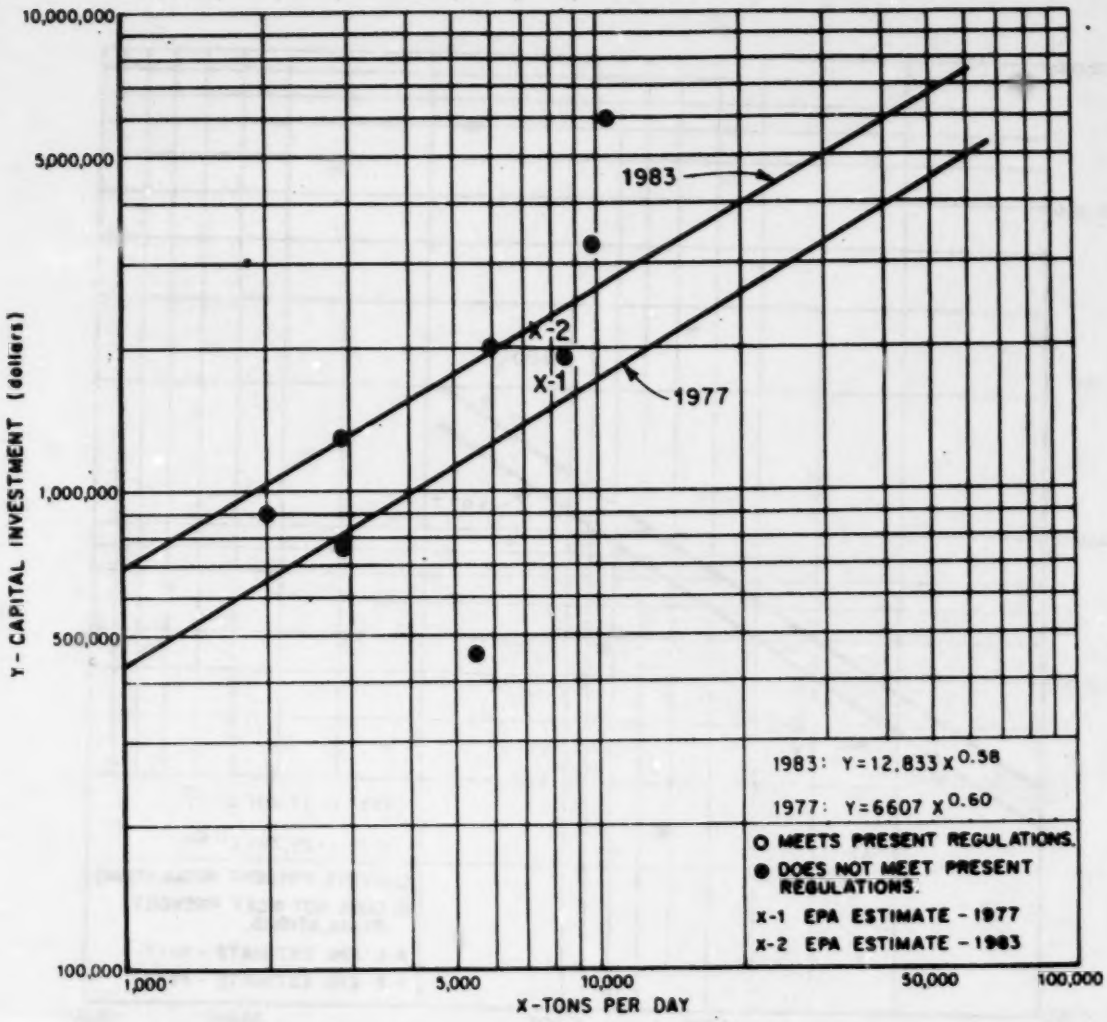


Figure 15. BATEA Capital Investment for Basic Oxygen Furnace (1972 Basis).

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Used with permission American Iron and Steel Institute.)

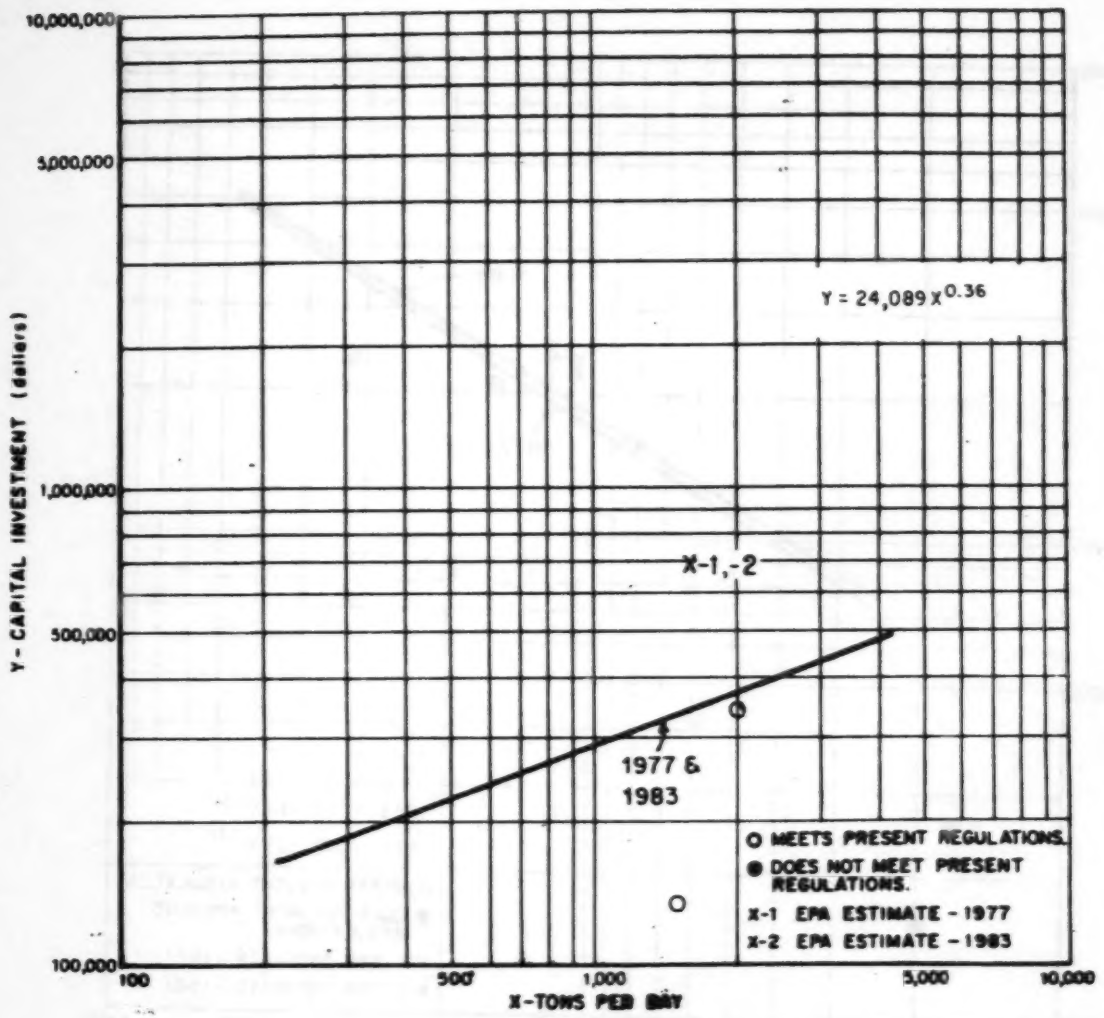


Figure 16. BATEA Capital Investment for Electric Arc Furnace - Semi-Wet Process (1972 Basis).

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Used with permission of American Iron and Steel Institute.)

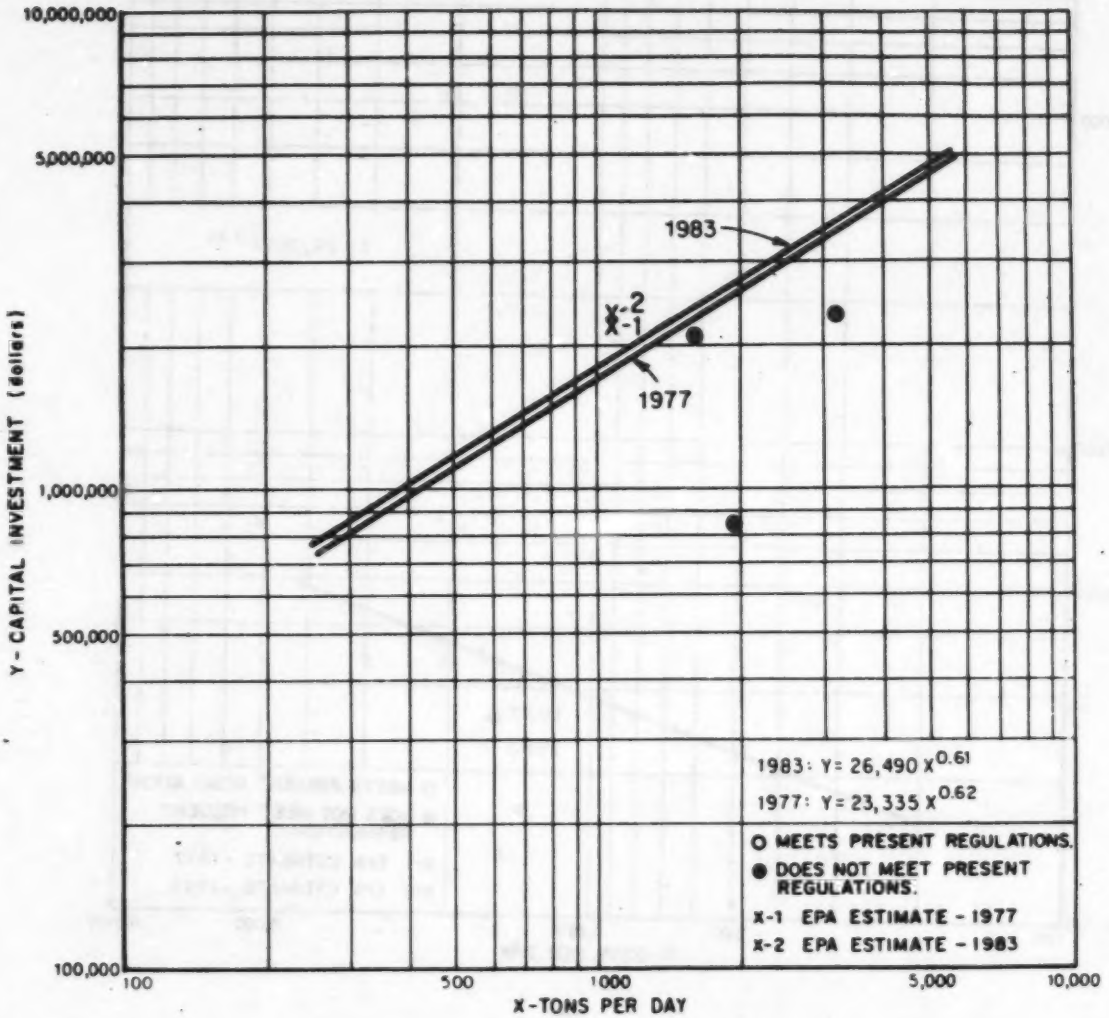


Figure 17. BATEA Capital Investment for Continuous Casting (1972 Basis).

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Used with permission of American Iron and Steel Institute.)

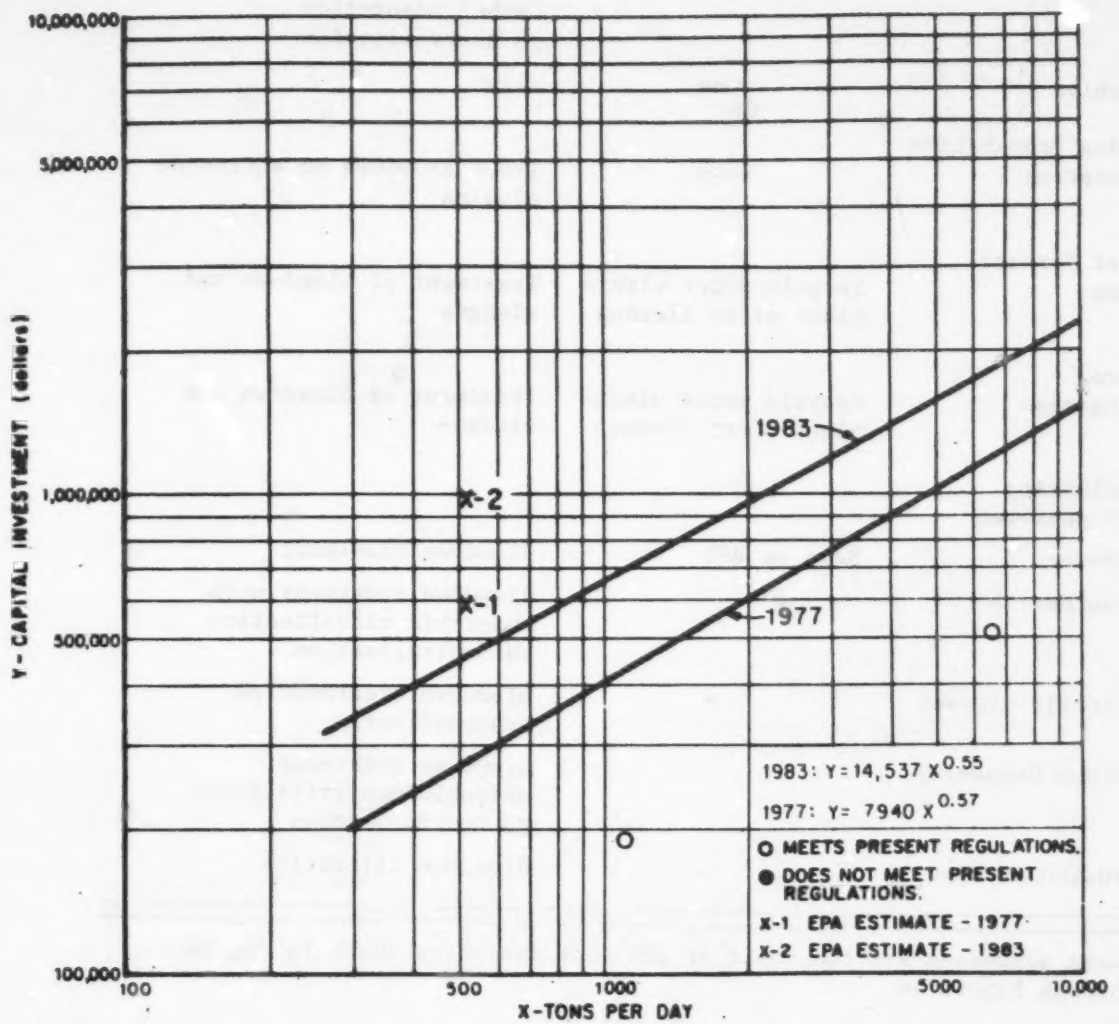


Figure 18. BATEA Capital Investment for Vacuum Degassing (1972 Basis).

Source: Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975. (Used with permission of American Iron and Steel Institute.)

TABLE 2. TREATMENT TECHNOLOGY*

Process	In-plant Change	End-of-pipe Treatment
Coke-making	-	-
By-product		Alkaline Chlorination pressure filtration, Carbon Adsorption pH neutralization
Beehive	none	none
Burden Preparation		
Sintering	none	Treat blowdown to activated alumina
Blast Furnace		
Iron	Recycle water within plant after cleanup	Treatment of blowdown and sludges
Ferro		
Manganese	Recycle water within plant after cleanup	Treatment of blowdown and sludges
Steelmaking		
BOF-semi-wet		
BOF-wet	Same as BPT	Blowdown treatment
Open Hearth	-	Blowdown treatment with anaerobic nitrification pH neutralization
Electric arc-wet	-	Blowdown treatment pH neutralization
Vacuum Degassing	-	Blowdown treatment anerobic denitrification pH neutralization
Continuous Casting	-	Blowdown filtration

*These processes are the basis of the cost estimates shown in Figure 4 through Figure 18.

REFERENCES

1. US-EPA Development Document for Effluent Guidelines for the Iron and Steel Industry, PB 238837, NTIS.

2. Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, May, 1975.

3. Popper, Herbert, Editor, Modern Cost Engineering Techniques, McGraw Hill Book Company, New York, 1970.

4. US-EPA, Choosing Optimum Financial Strategies, Technology Transfer Seminar Publication, June, 1976.

5. Jelen, F.C. Editor, Cost and Optimization Engineering, McGraw Hill Book Company, New York, 1970.

6. Chemical Marketing Reporter, November 14, 1977.

7. Chemical Engineering, vol. 84, no. 20. November, 1977.

8. U.S. Department of Commerce, Survey of Current Business, published monthly.

9. Temple, Barker, Sloane, draft copy, Economic Analysis of Proposed and Interim Final Effluent Guidelines for Integrated Iron and Steel Industry, March, 1976.

EXHIBIT 1

BAT CAPITAL COST SPECIFICATION

1. Process Category:
2. Process Subcategory:
3. Process Capacity:
4. Design Basis:

CAPITAL COST ITEM	IN-PROCESS COST	END-OF-PIPE COST	TOTAL COST
5. Land			
6. Site Preparation			
Grading			
Sewers			
Roads-Walks			
Foundations			
Structures Supporting Equipment			
7. Equipment			
Pumps			
Tanks-storage			
Tanks-treatment			
Filters			
Compressor Fans and Blowers			
Conveying Equipment			
8. Instrumentation			
9. Piping			
10. Insulation			
11. Electrical equipment			
12. Construction expense-			
a. Dismantling; demolition			
b. New construction			
13. Engineering Services			
14. Insurance			
15. Taxes			
16. Contingency			
17. Total Capital Cost			

EXHIBIT 2

BAT OPERATING COST SPECIFICATION

1. Process Category:
2. Process Subcategory:
3. Process Capacity:
4. Treatment Design:

5. VARIABLE COSTS	UNIT COST	UNITS	TOTAL ANNUAL COST
a) Chemicals			
b) Labor			
c) Maintenance			
d) Supervision			
e) Utilities			
electricity			
air			
water			
steam			
f) Overhead			
g) Waste Disposal			
6. FIXED COSTS			
a) Cost of Capital			
Interest rate			
b) Depreciation			
average equipment life			
salvage value			
method of depreciation			
c) Taxes			
d) Insurance			
7. CREDITS			
8. TOTAL ANNUAL COST			

INSTRUCTIONS FOR COMPLETING EXHIBIT 1 and EXHIBIT 2

The forms attached are to be completed by the appealing company for each process category which may be affected under the appeal.

EXHIBIT 1 INSTRUCTION

1. and 2. Name the process category and subcategory for which the costs have been estimated.

3. Specify the total process capacity in ton per day for which waste treatment is required. This capacity should represent the maximum monthly level achieved in the last five years.

4. Specify the treatment technology and design basis for the costs presented. Include flow rates, detention times, and a flow sheet of the proposed system.

5. thru 13. Capital cost items are broken down into typical elements of estimation. For cases where in-process changes are required in addition to the effluent treatment, these values should be segregated into the appropriate columns.

7. thru 11. Indicate equipment and instrument costs based upon installed cost estimates with minimum auxiliary supports.

12. Construction costs incurred, such as dismantling fixtures to prepare the site, demolition, or repair work should include labor and material charges.

13. Engineering services include costs for research and development, pilot plant work, consulting fees, and other costs for designing and directing the installation of treatment facilities. Cost items would be supplies, labor, administrative, and overhead expenses.

14. Insurance costs associated with the project addition should be included.

15. Taxes incurred on a one-time basis are itemized here.

16. A contingency fund for the pollution project can be specified but should not exceed 10% of the total project cost.

17. The total capital cost is the sum of items 4 through 15.

EXHIBIT 2 INSTRUCTIONS

1. and 2. Name the process category, subcategory for which costs have been estimated.

3. Specify process capacity in tons per day for which waste treatment is required. This capacity should represent the maximum monthly average in the last five year period.

4. Specify the treatment technology and design basis for the costs presented. Include flow rates, detention times, and a flow sheet of the proposed system.

5. Variable costs of operating the BAT pollution facilities are itemized in a) through g). Please list the unit cost, total units required, and total annual cost for each of these items.

6. Fixed costs of operating pollution control equipment costs of items a) through d). The cost of capital a) and depreciation expense b) may be combined into one amortization rate if desired.

   6a. List the interest rate utilized in determining the cost of capital and the financing method which is considered for obtaining funds.

   6b. Please specify the depreciation method, the average number of years for equipment life, and salvage value used in calculating the depreciation expense.

   6c. List the incremental taxes increase associated with this project.

   6d. List the incremental insurance costs associated with this project.

7. Costs savings due to reduced chemical usage or other expenses should be entered as a credit to pollution control costs.

8. Add items 5 and 6 and subtract the value of item 7 to determine the total annual cost.

Appendix A

COMMENTS FROM US-EPA REGIONAL PERSONNEL REGARDING DRAFT COST FORMAT

Aspect of Format	Comment
1. Type of Cost Information Presented	Region V - The most useful cost information would be general cost curves for various production levels or plant sizes. These costs should also be presented on a per unit production basis if possible.
	Region III - With the proposed 301C regulation implemented, cost verification would not be required. It is important, however, to develop cost curves associated with BATEA treatment processes and treatment processes not specified as BATEA by the US-EPA. The BATEA treatment processes do not necessarily represent the most cost-effective way of achieving BATEA effluent levels, and perhaps other methods and their costs could be presented.
2. Nature of Cost Format	Region V - It is good to specify the format for cost elements and to identify as particularly as possible the cost elements included. Separation of in-plant versus end-of-pipe costs is vital.
	Region III - A format for the cost presentation is useful if all cost elements are broken down and identified. Verification of costs will not be a major regional responsibility but understanding and analyzing elements is important.
3. Specific Cost Elements	Region V - Presentation of specific equipment cost data would be useful. Designate the installed versus purchase price of equipment. Specific inclusion of site preparation such as dismantling of existing equipment is an important cost. It is important to have reference for verifying or obtaining additional cost information.
	Region III - Equipment costs are valuable but also the cost presentation must be viewed in terms of the economic analysis. Discussion of financing, depreciation, and interest rates are important to the actual use of such a format. Inclusion of cost credits in the format is important.